BULLETIN OF THE UNIVERSITY OF SANTA CLARA

Vol. II No. 3

University of Santa Clara

College of Engineering

SANTA CLARA, CALIFORNIA
MARCH, 1913

Entered as second class matter in the Postoffice at Santa Clara, Cal.,
on July 29, 1912, under Act of July 17, 1894

PUBLISHED QUARTERLY

BULLETIN OF THE UNIVERSITY OF SANTA CLARA

Vol. II. No. 3

University of Santa Clara

College of Engineering

ANNOUNCEMENT
1913-14

Published by the University Press
Santa Clara, Cal.

Re-opening of the University, Registration, Etc.

First Semester.

Tuesday, Sept. 2, 1913—Registration and classification of new non-resident students. Examination to remove conditions of old students.

Wednesday, Sept. 3—Registration and classification of new resident students. Examination to remove conditions of old students.

Thursday, Sept. 4—12:30 P. M.—All resident students must report to the Director of Discipline.

1:00 P. M.—All non-resident old students must register at the office of the Director of Studies.

1:45 P. M.—All resident old students must register at the office of the Director of Studies.

2:30 P. M.—Classes begin in all departments.

Second Semester.

Monday, Jan. 5, 1914, 8:50 A. M.—Registration and classification of new students.

10:00 A. M.—All non-resident old students must register at the office of the Director of Studies.

11:00 A. M.—All resident old students must register at the office of the Director of Studies.

1:30 P. M.—Classes begin in all departments.

Monday, Jan. 19—Last day for the removal of conditions.

N. B.—Students who fail to register at the time prescribed are charged one dollar for registration.

The Corporate Title of the University is

THE PRESIDENT AND BOARD OF TRUSTEES OF SANTA CLARA COLLEGE

BOARD OF TRUSTEES

JAMES P. MORRISSEY, S. J.
President

JOHN J. LAHERTY, S. J.
Secretary and Treasurer

ALOYSIUS V. RAGGIO, S. J. JEROME S. RICARD, S. J.

*ROBERT E. KENNA, S. J. WM. CULLIGAN, S. J.

CHARLES M. LORIGAN, Esq.

EXECUTIVE BOARD

THE PRESIDENT JOHN J. LAHERTY, S. J.

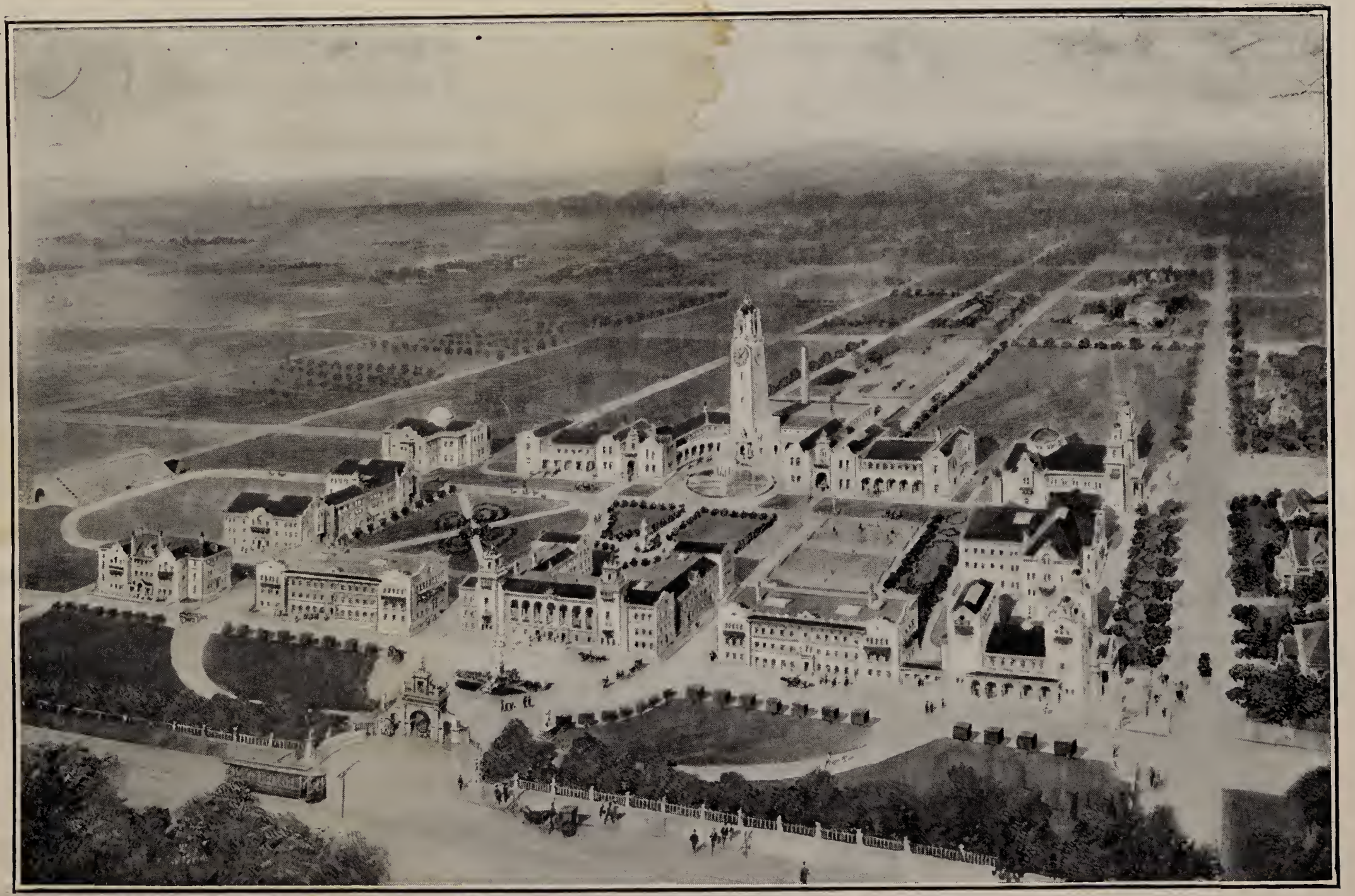
CHARLES M. LORIGAN, Esq.

Consulting Attorney

CHARLES M. LORIGAN, Esq.,
San Jose, Cal.

---

* Deceased



Faculty of the College of Engineering

JAMES P. MORRISSEY, S. J.,
President.

CORNELIUS A. BUCKLEY, S. J.,
Dean of the Faculty.

ALBERT F. PORTA, C. A., C. E.,
Professor of Architecture.

JOSEPH L. DONOVAN, C. E.,
Professor of Civil Engineering.

GEORGE L. SULLIVAN, M. E.,
Professor of Mechanical Engineering.

JUSTIN J. GRIMES, B. A.,
Instructor in Engineering Mathematics.

RICHARD H. BELL, S. J.,
Professor of Physics.

JEROME S. RICARD, S. J.
Professor of Philosophy and Political Economy.

WILLIAM M. BOLAND, S. J.,
Professor of Philosophy.

JOSEPH A. VAUGHAN, S. J.,
Professor of Chemistry.

ALPHONSE J. QUEVEDO, S. J.,
Professor of English and Spanish.

ERIC E. PRITSCHOW, A. M.,
Instructor in German and French.

JAMES H. CAMPBELL, A. M., J. D.,
Professor of Law.

INDEX

UNIVERSITY OF SANTA CLARA

ITS FAVORED LOCATION

The University, with its numerous buildings and spacious and beautiful grounds, where stately palms wave their banners seventy feet in air, is the principal feature of the interesting Mission town of Santa Clara, in the beautiful valley of the same name. It lies in Central California, forty-eight miles south of San Francisco, a city of half a million inhabitants, and is separated from San Jose, the chief city between San Francisco and Los Angeles, only by the historic Alameda, three miles long. San Jose and Santa Clara are in reality one city of more than 60,000 inhabitants, located in the center of the most densely populated valley of California. The Valley of Santa Clara is famous throughout the world for the rare beauty of its scenery, the salubrity of its climate, and the excellence of its fruits. The climate is mild and equable both in summer and winter, and on that account singularly favorable to the prosecution of persistent study and deep research. While never oppressively hot, this climate is far sunnier than the Sunny South, especially in winter; more genial and balmy than Italy or Andalusia.

When this locality was little more than a wilderness, its attractions of climate, location and scenery fascinated Bayard Taylor, the greatest traveler America has produced. Of all places on earth, to him the land of Eden was California, and of all places in Cali-

fornia, the Vale of San Jose (as he understood it was called). Again and again he refers to it in terms of the most glowing praise.

Beside the road over which the great traveler was glad to travel in a carriage, a multitude of trains, several of them transcontinental, now rush daily. All the way from San Jose to the great city of San Francisco fifty miles away, the slopes are adorned with lovely homes; the jungles of mesquite and chaparal, so dense as hardly to allow the passage of a rabbit, have given place to trim orchards, luxuriant gardens, and pleasant homes.

FOUNDATION

It is in this scene that the University of Santa Clara is set. It is located on the site of the Old Mission of Santa Clara, Santa Clara, California.

On January 12, 1777, two Franciscan Padres, de la Pena and Murguia, planted the Mission Cross on the banks of a little stream, called from that time the Guadalupe, at a spot now forming a part of the Laurel Wood Farm, near the Agnew Asylum. Two years later, a flood destroyed the primitive buildings, both church and monastery, and the Padres in consequence sought a site on higher ground near the present railway station of Santa Clara.

There, on November 9, 1781, they laid the foundations of a large adobe church and mission buildings. Three years later, on May 15, 1784, the new church was dedicated, by the Venerable Padre Serra, then Padre Presidente of all the Missions of California.

This church, however, was so badly shattered by

several earthquakes in 1812 and 1818, that the Padres were forced to build anew. This time they chose the site which the University now occupies. There on August 11, 1822, the same Padre Serra dedicated a still larger church which did service for many years till the violent earthquakes in the years 1865 and 1868 so cracked and weakened it that extensive repairs were necessary. By the year 1885 it had been almost entirely removed, having been gradually replaced by the present wooden edifice, the interior of which is a nearly perfect facsimile of its predecessor, retaining as it does, some of the old ornaments and furniture and the very ceiling of its sanctuary; while the other parts are so designed as to be a faithful reproduction of the original church.

The Mission of Santa Clara was secularized in 1836 and passed from the hands of the devoted Padres into those of politicians, who in dealing with the helpless Indians violated as well God's laws of right and justice, as the laws of the Mexican government in whose name they ruled. Santa Clara was soon robbed of her lands, and her children were oppressed or driven away to the forests.

When Rt. Rev. Joseph Sadoc Alemany, O. P., arrived on the scene, as Bishop of the Diocese of San Francisco in 1850, he found one lone Franciscan in charge of the mission, which had been restored by the American government, though in a sadly reduced form, most of the land being occupied by squatters.

Desiring to save the remnants of the mission, and also to start a college to meet the growing need of the times, the Bishop invited the Society of Jesus to Santa Clara. The invitation was accepted, and ac-

cordingly on March 19, 1851, the Rev. John Nobili, with a capital of "one hundred and fifty dollars and a brave heart," laid the foundation of the University of Santa Clara and began the work.

Nobili adapted the old adobe buildings to the requirements of a school, and in a few years numerous students were in attendance. In 1856 in the midst of his works he was stricken down, not, however, before he had seen the institution he had founded, on April 28, 1855, chartered a university.

Men after his own heart offered themselves to carry on his work, and students came from every part of California, as well as from neighboring states, so that the influence of Santa Clara was felt from the very outset. This influence has steadily increased and now there is hardly a city or town in the West which does not count an alumnus of the pioneer University among its most loyal and eminent sons.

THE PRESENT

The popularity of the University has steadily increased in the course of years. An ever increasing number of students give evidence of the efficiency of the education and training it imparts. Owing, however, to the fact that only a limited number of students could be accommodated this growth of Santa Clara has been greatly hampered.

Even more pronounced than this material growth has been the improvement wrought in the student body by the judicious selection of applicants for admission and the no less judicious elimination from the University, of students whose moral influence

was not helpful. The principle of the faculty has been to receive and retain no one whose manners are not gentle and whose habits are not irreproachable. Today parents realize that education which neglects manners is a mistake and that a university which overlooks or takes little account of morals is a monstrosity.

CONSTITUENT COLLEGES

The University now posseses the following constituent Colleges: The College of Philosophy and Letters; The College of General Science; The Institute of Law; The College of Engineering, embracing Architecture and Architectural, Civil, Electrical and Mechanical Engineering; The School of Pedagogy; and the Pre-Medical Course.

FUNDS AND NEW BUILDINGS

The growth in the number of her students of recent years has made it imperative to provide ampler and more substantial accommodations for the students. For this and in order that Santa Clara may widen her scope as a first class educational institution, funds are necessary. Santa Clara stands in imperative need of an endowment. The work the University has accomplished in the past is an earnest of what she will do when increased facilities are afforded her.

An endowment, however, implies a founder or founders and benefactors. During the past few years many have helped the University and generous

donations have been made. The Administration building, 200x43 feet, and the Senior Hall, both in reinforced concrete, are completed, and the Engineering building is shortly to be begun. But before other buildings for which the plans of the University provide, may be added, further benefactors will be needed. Other educational institutions, even those state-aided and richly endowed receive generous assistance in the work and hesitate not to ask it. Santa Clara feels that generous friends are not lacking, though for the want of deeper thought on the matter, few realize the importance of Christian Educational work, the immense sacrifice it entails, and the merit there is in co-operating and sharing with Christian educators in their work for God and Country and the welfare of the young men of our generation who are to become the leaders of the generation of tomorrow. The faculty of the University has given its life-services freely and gladly to the work. Those who would share with them in this great enterprise can do so most effectively by rendering material aid and contributing funds for the continuance and development of the work.

FORM OF BEQUEST

I give and bequeath unto the President and the Board of Trustees of Santa Clara College, a corporation duly incorporated under the laws of the State of California, a sum of..... dollars.

SYSTEM OF EDUCATION

The Jesuit system of education aims at developing side by side, the normal and intellectual faculties of the student, and sending forth to the world men of sound judgment, of acute and rounded intellect, of upright and manly conscience. And since men are not made better citizens by the mere accumulation of knowledge, without a guiding and controlling force, the principal faculties to be developed are the moral faculties. Moreover, morality is to be taught continuously; it must be the underlying base, the vital force supporting and animating the whole organic structure of education. It must be the atmosphere the student breathes. It must suffuse with its light all that he reads, illumining what is noble and exposing what is base, giving to the true and false their relative light and shade.

STUDIES

It is one of the decided advantages of the system followed at Santa Clara, that the student may begin his studies in the Preparatory School conducted under the supervision of the University authorities, and then pass on, through the University Course, to graduation under the same direction and influence. This secures, besides the moral influence thus gained, a uniform and homogeneous course of teaching and training. The result of this system is a continuous and normal development of the mental faculties along well defined lines, and the possession of a clear and coherent system of principles upon the subjects which he has studied.

SESSIONS, HOLIDAYS, HOURS

The school year consists of two semesters.

The weekly holiday is on Wednesday.

Lectures and classes begin daily at 8:50 A. M. and close at 3:30 P. M.

COMMITTEES

Examinations—

Sophomore—The Professors of Sophomore and Freshman Courses.

Junior—The Director of Studies, and the Professors of the Junior Courses.

Senior—The President, the Director of Studies, and the Professors of the Senior Courses.

Theses—The Director of Studies and the Professors of Junior and Senior Courses.

Athletics—The Director of Discipline, the Director of Studies and the Faculty Director, assisted by the Officers of the Student Body.

Dramatics and Public Exercises—The President, the Director of Studies, the Director of Discipline, the President of the Senior Dramatic Club, and the Professors of English.

"The Redwood"—The Director of Studies, the Faculty Director guiding the staff, and the Professors of Philosophy and English.

Post-Graduate Studies—The President, the Director of Studies, and the Professors of the subjects in which the Post-Graduate work is taken.

Discipline—The Director of Discipline, the Assistant Director of Discipline and the Director of Studies.

Attendance—The Director of Studies, and the Director of Discipline.

Scholarship and Standing—The Director of Studies, and the Deans of the several Colleges.

The University Bulletin—The President, the Director of Studies and the Faculty Director of the Redwood.

SCHOLARSHIPS

Every year several deserving young men of high character and aspirations, whose means do not permit their attending the university, appeal to the Faculty for assistance to obtain the education for which their talents and vocation fit them. There is scarcely a university in the United States which is not provided with a fund for this purpose, and a relatively large percentage of successful college men spring from the class of assisted students. It is clearly a noble benefaction to contribute to such a purpose in any case. But this is especially so in the case of those who apply for help to the University of Santa Clara. They are as a rule young men of high standing, who understand the paramount value of an education in a university which aims at the highest intellectual development of the student, while devoting no less attention to the perfect development of his moral character. As a consequence it follows that to assist them in attaining their desire is to aid picked young men whose future is more than ordinarily full of promise, and who are destined to exert a most powerful influence on those among whom their lives will be spent.

It is the intention of the Faculty of the University of Santa Clara to make an earnest effort to supply this pressing need, by establishing free scholarships for resident and non-resident students, so that worthy young men may receive the help they desire. For this purpose an appeal is made to all who appreciate the importance of the matter.

The Scholarships to be founded will be of two classes, perpetual and temporary. By establishing a perpetual scholarship the donor will maintain one student at the University of Santa Clara in perpetuity. A temporary scholarship will maintain one student at the University during the four years of his course. The amount contributed will be invested in reliable securities, the interest of which will support the student. The cost of founding Scholarships is as follows:

Perpetual Scholarship for a resident student—board, lodging, etc., tuition, text-books	$12,500.00
A perpetual Scholarship for a day student—tuition and text-books	$ 3,000.00
A temporary Scholarship for a resident student—board, lodging, tuition, text-books, for four years	$ 2,000.00
A temporary Scholarship for a day student—tuition, text-books, etc., for four years	$ 500.00

It is the desire of the Faculty to name these Scholarships after their founders, that thus the recipients of their generosity may know to whom they are indebted for their education, and ever retain grateful rememberance of them.

We are pleased to announce that the first perpetual Scholarship for a resident student has this year been established through the generosity of a Friend in memory of the late Mrs. Alice Phelan Sullivan. It will be known as the Alice Phelan Sullivan Memorial Scholarship.

GENERAL REGULATIONS

No one will be admitted as a student unless he has a good moral character.

Candidates for admission must present satisfactory recommendations. Those from other educational institutions must be recommended by the institutions whence they came. For scholarship requirements cf. Graduate and Undergraduate Departments.

Students are not received for a shorter period than one semester.

As the Faculty of the University profess the Catholic Religion, the exercises of religious worship are Catholic; but members of any religious denomination are received, provided they be willing, for the sake of order and uniformity, respectfully to conform to the religious observances of the University.

No student will be permitted to leave the University on visits of any length, except at the Christmas holidays from the twenty-third of December to the third of January, if such be the wish of his parents or guardian. Parents are requested not to call their sons home at other times, except in cases of urgent necessity, as such interruptions, besides tending to undermine or prevent the acquisition of habits of concentration and preserving work, are apt to result in poor scholarship and in the consequent wrecking of the whole career of the student.

A recess at Thanksgiving and Easter may be given at the discretion of the President.

Students who, having left the University for the summer vacation, or Christmas holidays, fail to be present on the day for the re-opening of class, will, by the fact of absence, be excluded from the University, or at the discretion of the Faculty from privileges until the following semester, particularly the privilege of visiting friends and relatives on the Second Wednesday, unless parents or guardians show cause of absence, which the Faculty shall consider wholly sufficient.

The students are not allowed the use of tobacco, except in First Division with written permission from parents or guardians.

Students are not permitted to have books or other publications that have not been approved by theVice President.

To cultivate the heart, no less than to develop the intellectual and physical faculties of the students, is a duty kept constantly and sacredly in view.

The students' correspondence is subject to the inspection and control of the President.

To hold meetings or to form clubs or societies of any kind without the consent of the President; the habitual use of profane language; gross immorality committed either within or without the precincts of the Institution; the possession or distribution of immoral publications or pictures; intoxication; procuring or introducing intoxicating liquors, directly or indirectly into the University; habitual idleness and vio-

lation of the rules of the University; obstinate refusal to submit to a punishment inflicted; absence from the University at night without leave from the President; avowed principles of infidelity; express contempt or ridicule of religion, are offenses which expose the offenders to dismissal.

EXPENSES IN ALL THE DEPARTMENTS OF THE UNIVERSITY

RESIDENT STUDENTS

Marticulation Fee to be paid but once	$ 15.00
Board, Tuition, Lodging, including washing and mending of linen, per semester	200.00
Fee for athletic activities, per semester	2.50

NON-RESIDENT STUDENTS

Tuition in University Course, per semester	50.00
Tuition in High School Course, per semester	30.00
Fee for athletic activities, per semester	2.50
Dinner, per semester	35.00

ADDITIONAL EXPENSES

Furnished Room and attendance, per year, double rooms	60.00
Furnished Room and attendance, per year, double rooms used for one person	120.00

A few rooms are reserved at a higher rate.

No room shall be considered engaged unless a deposit of $25.00 has been made for the same. On his actual entrance into the University, half of this amount will be credited to the student's account, and the other half will be retained as security against damage to room or furniture.

Law students' deposit for books, per year	25.00
Pre-Medical Laboratory, per semester	25.00

Laboratory for Physics or Chemistry, students not in Engineering Courses, per semester	12.50
Modern Languages not in regular course, per year	20.00
Science deposit for breakage	5.00
Typewriting, full course	20.00
For each Academical Degree	10.00
For Commercial Certificate	5.00
For each extra examination	2.00

SUMMARY OF EXPENSES FOR ENGINEERING STUDENTS.

Tuition for all, per semester	50.00
Freshman Laboratory, etc., per semester	12.50
Sophomore Laboratory, etc., per semester	20.00
Engineering Laboratory, shop, use of instruments, etc., in Senior and Junior years, per semester	25.00
Architecture—Freshman year, per semester	12.50
Sophomore year, per semester	20.00
Junior and Senior years, per semester	25.00
Science deposit for breakage	5.00

ALL CHARGES MUST BE PAID HALF YEARLY IN ADVANCE.

No expenditure for clothing or for incidental expenses of any student and no advances for pocket money will be made by the Insitution, unless an equivalent sum has been deposited with the Treasurer of the University.

Books and stationery are furnished at dealers' rates.

No rebate will be allowed in favor of those who enter later, nor, in the case of any student, for absence at the opening of the semesters in September and February. No reduction is made when students are withdrawn from the University during the semester for other reasons than serious illness. Degrees will not be conferred on any student whose account with the University has not been settled.

An itemized bill is sent at the end of each semester.

(1) Semester bills and other accounts are subject to sight draft if not paid within ten days after they have been rendered.

(2) Remittances should be made payable to the order of the University of Santa Clara.

(3) No one may be temporarily or permanently withdrawn from the University without the President being directly notified. In either event money should be sent for the trip, and, in the latter, accounts ought also to be settled.

(4) A limited number of student waiters can be received at reduced rates.

(5) There are no charges for the services of the College physician. Medicines procured at the College infirmary will be charged as used by individuals.

A HEALTH REQUIREMENT IS EXACTED.

All students are subject to examination by the College physician.

COLLEGE OF ENGINEERING

The foundation of the College of Engineering in the University of Santa Clara was the result of repeated and urgent requests that opportunities should be given young men, ambitious to follow the Engineering profession, to pursue and complete the studies leading thereto in an environment and atmosphere conducive as well to deep persevering study as to cultural and moral development.

To meet this demand, the Faculty of the University has added sound and thorough courses in Architectural, Civil, Electrical and Mechanical Engineering. Each of these departments is in the hands of experienced and practical engineers who devote their whole time and attention to the success of their work. As is traditional at Santa Clara, students in Engineering are given individual care, assistance, advice and encouragement. The work exacted is of the highest type, nevertheless, owing to this individual care and to the judicious admission of students as well as the prompt elimination from the various departments of students found to be inadequately prepared in fundamental studies or in seriousness of purpose, there is very little likelihood and no excuse for failure on the part of the student.

The demand for engineers is today greater than ever before. Owing to the vast extent of our State and of the neighboring States, as well as of Alaska on the North and the Great Mexican and Central American Republics on the South, with which Cali-

fornia is so intimately connected, and owing moreover to the fact that these countries are as yet comparatively undeveloped and that California, on account of her unexcelled climate and almost unlimited natural sources of power, is bound to take her place among the foremost manufacturing states of the Union, it is evident that this demand for first class engineers will go on increasing for many decades to come. Logically it is California that should supply a very great proportion of this demand. The young men of our State have, therefore, a most powerful incentive to enter the engineering profession in its various branches, in which, granted a broad and thorough preparation, they are assured of success.

That this preparation can be given by mere technical schools is no longer contended. The engineer today must be more than a machinist, electrician or surveyor. He can no longer be a self-made man in the old sense. His mind must possess the acumen and culture which only a broad college training and college association can give, and his acquaintance with and love of mathematics and science should be the foundation on which his knowledge of their technical applications is based.

This is the ideal which Santa Clara cherishes for the engineers who shall receive their education from her.

COURSES.

Four year Courses are offered leading to the degrees of Bachelor of Science in Architecture, Bachelor of Science in Architectural Engineering, Bachelor of Science in Civil Engineering, Bachelor of Sci-

ence in Electrical Engineerng and Bachelor of Science in Mechanical Engineering. These courses aim, first, to give the student a thorough knowledge of the sciences on which all Engineering is based, second, to develop his ability to acquire accurate information, third, to develop his judgment by practical work so that he may be able to use his knowledge and information to the best advantage.

ARCHITECTURE AND ARCHITECTURAL ENGINEERING.

The Courses in Architecture and Architectural Engineering give facility in the application of the fundamental principles of beauty and strength to buildings. Architectural forms and principles and their application in Architectural design are taken up, together with the strength of materials and the design of trusses, columns and reinforced concrete, the whole enabling the student to produce correct, beautiful and economical works of Architecture. The course in Architecture is intended for those who wish to specialize in pure design leaving the determination of the size of the more complicated members of their structures to an engineer. The course in Architectural Engineering is intended for those whose mathematical ability will allow them to design structures, not only for shape, but also for strength.

CIVIL ENGINEERING.

Civil Engineering covers the field of structural work (steel, concrete and stone buildings and bridges), municipal engineering (roads, pavements

and sewers), water power development, irrigation and railroad construction. These are all based on the fundamental sciences of Mathematics, Physics and Chemistry, and as much practice as possible is given to facilitate the application of these sciences to professional work.

ELECTRICAL ENGINEERING.

Electrical Engineering has to do with the design and construction of electrical machinery and the various applications of electricity to the arts. Electrical and Mechanical Engineering are so closely interrelated that the first three years are the same, and it is only the Senior courses, such as Telephony and pure Electrical design, that are differentiated from the Mechanical Engineering courses.

MECHANICAL ENGINEERING.

Mechanical Engineering may be divided into three closely related lines, Design, Manufacturing and Power Generation. The courses in Design begin with mechanical drawing and continue with a study of mechanisms, strength of materials, stresses in, adaptability, cost, and commercial worth of machines.

Manufacturing has to do with the organization of commercial enterprises, systems of works management, efficiency systems, cost of materials and power and layout of machinery in a factory for maximum output. The subject of Power Generation is covered by courses on steam and gas engines, turbines, boilers, water motors and electric generators, together with

the proper operation of all classes of machinery and the application of power thereto.

ENTRANCE REQUIREMENTS.

Applicants for admission to the Freshman Year of the College of Engineering must either (1) have completed the regular Four-Year High School course of the Preparatory School of the University, or (2) have completed a similar course in an accredited High School, or (3) pass an examination based on a four-year course amounting in the aggregate to fifteen units. Of these fifteen units, ten or more are prescribed and required of all applicants; the rest are elective from the list of optional subjects.

SUBJECTS PRESCRIBED.

English	3 units
History	2 units
Foreign Languages	2 units
Algebra	1½ units
Geometry	1½ units
Physics	1 unit

ELECTIVES.

Chemistry	1 unit
Foreign Languages	2 units
English	1 unit
History	2 units
Trigonometry	½ unit

To count a "unit" a subject must be taught five times a week, in periods of not less than forty-five minutes, for a school year of not less than thirty-six weeks.

CONDITIONS.

In certain cases, at the discretion of the Committee on Entrance Standing, which shall decide on the merits of each particular case, conditions in elective branches to the amount of not more than two units may be allowed. All conditions must, however, be removed by the end of the Freshman year.

TO APPLICANTS.

Fill out an application blank and forward same to the President, enclosing a certificate of the studies you have completed with a testimonial as to your character and diligence, signed by the Principal of the school you have last attended.

The articles which each student should bring with him are, more or less: two pairs of sheets, three pillow cases, two counterpanes, three suits of clothes, a sufficient number of shirts, drawers, handkerchiefs, socks, shoes, napkins, towels, combs, brushes, etc., all, without exception, marked with his name distinctly and imperishably before he comes.

Promptness in reaching the University on the day fixed for the opening of classes is necessary. It is essential that Parents and Students understand this clearly from the beginning of their connection with the University, as promptness in returning from vacations and recesses, which is requisite in order to prevent the loss of valuable time and the forming of habits of procrastination and negligence of duty, is strictly insisted on.

REQUIREMENTS FOR GRADUATION.

CREDITS.

In all of the groups of the College of Engineering, 176 credits are required for graduation. A credit is given for each one-hour recitation, or lecture, (requiring one hour preparation) per week, carried satisfactorily for one semester, or for two hours per week, spent in a laboatory, drawing room or shop, for one semester.

REQUIRED SUBJECTS.

The subjects required for graduation are given under appropriate headings on the following pages.

GRADES.

Semester grades are expressed on a basis of 100 for perfect work.

70 is required for passing.

60-70 indicates a condition.

Below 60 indicates a failure.

A student making 70 or more in any course is given the credits for that course. If he makes from 60 to 70 he must pass a satisfactory examination at the time set for condition examinations or receive a failure in the subject.

If the condition is received in a laboratory course, the student must make up the work in which he is deficient before the time of the condition examinations, or receive a failure.

A failure in a subject means that the student must repeat the subject in class the next time it is given.

Students, who, on account of ill-health or other cause, are not able to carry 22 credits a semester, will be allowed to carry a lighter course, which will allow them to graduate in five years.

OUTLINE OF COURSES

FRESHMAN YEAR OF ALL FOUR YEAR COURSES.

First Semester.

	Hours Attendance Rec.	Lab.	Credits.
College Algebra, Eng. Math. (1)	3		3
Trigonometry, Eng. Math. (2)	2		2
Chemistry, Chem. (1)	3	4	5
Mechanical Drawing, M. E. (1)		6	3
English, Eng. (1)	3		3
French, German or Spanish, M. Lang. (1), (3) or (5)	4		4
Review of Engineering Industries, M. E. (9)	2		2

Second Semester.

Analytic Geometry, Eng. Math.—(3)	5		5
Chemistry, Chem. (2)	3	4	5
Descriptive Geometry, M. E. (2)	1	4	3
English, Eng. (2)	3		3
French, German or Spanish, M. Lang. (2), (4) or (6)	4		4
Review of Engineering Industries, M. E. (9a.)	2		2

ARCHITECTURE.

SOPHOMORE YEAR.

First Semester.

Strength of materials, Arch. (14)	4		4
Physics, Phy. (1)	3	4	5

	Hours Attendance Rec.	Lab.	Credits.
English, Eng. (3)	3		3
Freehand Drawing, Arch. (16)		4	2
Construction, Arch. (20)	2		2
Descriptive Geometry, Arch. (1)		4	2
Design, Arch. (3)		4	2

Second Semester.

Strength of Materials, Arch. (15)	4		4
Physics, Physics (2)	3	4	5
English, Eng. (4)	3		3
Freehand Drawing, Arch. (9)		4	2
History of Architecture, Arch. (17)	2		2
Construction, Arch. (2)	2		2
Descriptive Geometry, Arch. (2)		4	2
Design, Arch (4)		4	2

JUNIOR YEAR.

First Semester.

History of Architecture, Arch (18)	2		2
Freehand Drawing, Arch. (10)	4	4	2
Heating and Ventilating, M. E. (25)	2		2
Pictorial Drawing, Arch. (24)	1	4	3
Construction, Arch. (22)	3		3
Design, Arch. (5)		12	6
Philosophy, Phil. (1)	4		4

Second Semester.

History of Architecture, Arch. (19)	2		2
Heating and Ventilating, M. E. (26)	2		2
Freehand Drawing, Arch (11)		4	2

	Hours Attendance Rec.	Lab.	Credits.
Pictorial Drawing, Arch. (25)	1	4	3
Construction, Arch. (23)	3		3
Design, Arch. (6)		12	6
Philosophy, Phil. (2)	4		4

SENIOR YEAR.

First Semester.

Freehand Drawing, Arch. (12)		4	2
Sanitation, Arch (26)	2		2
Steel and Fireproof Details, Arch. (27)	2		2
Reinforced Concrete, C. E. (27)	2	2	3
Interior Decoration, Arch. (28)	2		2
Design, Arch (7)		8	4
Philosophy, Phil. (3)	3		3
Elective			4

Second Semester.

Freehand Drawing, Arch (13)		4	2
Business Law, Law (1)	1		1
Political Economy, Poly Econ (1)	2		2
Thesis, Arch. Thesis			8
Contracts and Specifications, C. E. (31)	2		2
Philosophy, Phil. (4)	3		3
Elective			4

ARCHITECTURAL ENGINEERING.

SOPHOMORE YEAR.

First Semester.

Calculus, Eng. Math. (4)	5		5
Analytic Mechanics, C. E. (7)	3		3
Physics, Physics (1)	3	4	5

	Hours Attendance Rec.	Lab.	Credits.
English, Eng. (3)	3		3
Construction, Arch (20)	2		2
Descriptive Geometry, Arch. (1)		4	2
Design, Arch. (3)		4	2

Second Semester.

Calculus, Eng. Math. (5)	5		5
Analytic Mechanics, C. E. (8)	3		3
Physics, Phy. (2)	3	4	5
English, Eng. (4)	3		3
Constructioin, Arch. (21)	2		2
Descriptive Geometry, Arch. (2)		4	2
Design, Arch (4)		4	2

JUNIOR YEAR.

First Semester.

Mechanics of Materials, C. E. (9) and (11)	3	4	5
Masonry, C. E. (20)	4		4
Graphic Statics., C. E. (18)	3		3
Structural Design, C. E. (14)		4	2
Architectural Design, Arch (5)		8	4
Philosophy, Phil. (4)	4		4

Second Semester.

Graphic, Statics., C .E. (19)	3		3
Structural Desgin, C. E. (15)		4	2
Pictorial Drawing, Arch. (24)	1	4	3
Architectural Design, Arch. (6)		12	6
Philosophy, Phil. (2)	4		4
Elective			4

SENIOR YEAR.

First Semester.

	Hours Attendance Rec.	Lab.	Credits.
Trusses, C. E. (22)	4		4
Concrete, C. E. (27)	2	2	3
History of Architecture, Arch. (16)	2		2
Heating and Ventilation, M. E. (25)	2		2
Sanitation, Arch. (26)	2		2
Interior Decoration, Arch. (28)	2		2
Design, Arch. (7)		8	4
Philosophy, Phil. (3)	3		3

Second Semester.

History of Architecture, Arch. (17)	2		2
Business Law, Law (1)	1		1
Political Economy, Poly. Econ. (1)	2		2
Contracts and Specifications, C. E. (31)	2		2
Thesis, Arch. Thesis			6
Philosophy, Phil. (4)	3		3
Elective			7

CIVIL ENGINEERING.

SOPHOMORE YEAR.

First Semester.

Calculus, Eng. Math. (4)	5		5
Analytic Mechanics, C. E. (7)	3		3
Physics, Phy. (1)	3	4	5
Geology, Geol. (1)	2		2
Surveying, C. E. (1)	1	2	2
Drawing, C. E. (12)		4	2
English, Eng. (3)	3		3

Second Semester.

	Hours Attendance Rec.	Lab.	Credits.
Calculus, Eng. Math. (5)	5		5
Analytic Mechanics, C. E. (8)	3		3
Physics, Phy. (2)	3	4	5
Mineralogy, Geol. (2)	2		2
Surveying, C. E. (2)	1	4	3
English, Eng. (3)	3		3
Drawing, C. E. (13)		2	1

JUNIOR YEAR.

First Semester.

Mechanics of Materials, C. E. (9)	3		3
Masonry, C. E. (20)	4		4
Graphics, C. E. (18)	3		3
Differential Equations, Eng. Math (6)	2		2
Field Engineering, C. E. (3)	1	4	3
Structural Design, C. E. (14)		4	2
Materials Testing Laboratory, C. E. (10)		2	1
Philosophy, Phil. (1)	4		4

Second Semester.

Hydraulics, C. E. (21)	3	2	4
Electricty, E. E. (14)	2	2	3
Graphics, C. E. (19)	3		3
Method of Least Squares, Eng Math. (7)	2		2
Field Engineering, C. E. (4)	2	4	4
Structural Design, C. E. (15)		4	2
Philosophy, Phil. (2)	4		4

SENIOR YEAR.

First Semester.

	Hours Attendance Rec.	Lab.	Credits.
Roofs, Bridges and Other Trusses, C. E. (22)	4		4
Roads and Pavements, C. E. (24)	2		2
Sewers and Sanitation, C. E. (25)	2		2
Geodesy and Astronomy, C. E. (26)		2	1
Concrete and Reinforced Concrete, C. E. (27)	2	2	3
Engineering in Field, C. E. (5)		6	3
Design, C. E. (16)		4	2
Tunneling , C. E. (28)	2		2
Philosophy, Phil. (3)	3		3

Second Semester.

Roofs, Bridges and Other Trusses, C. E. (23)	4		4
Political Economy, Pol. Econ. (1)	2		2
Irrigation, C. E. (29)	2		2
Railway Construction, C. E. (30)	2		2
Estimates and Specifications, C. E. (31)	2		2
Engineering in Field, C. E. (6)		4	2
Thesis, C. E. (17)			3
Business Law, Law (1)	2		2
Philosophy, Phil. (4)	3		3

Note. A month of practical field-work under actual conditions at the University farm at Loyola, in the foot-hills of Santa Clara County, is required during the vacation at the close of the Junior and of the Senior year. See Announcement on page 63.

The credits of the Junior and Senior years are not complete without these courses, unless the student has had the equivalent in actual practice in civil engineering.

ELECTRICAL AND MECHANICAL ENGINEERING.

SOPHOMORE YEAR.

First Semester.

	Hours Attendance Rec.	Lab.	Credits.
Calculus, Eng. Math. (4)	5		5
Analytic Mechanics, C. E. (7)	3		3
Physics, Physics (1)	3	4	5
Kinematics, M. E. (3)	2		2
English, Eng. (3)	3		3
M. E. Laboratory, M. E. (15)		4	2
Shopwork, M. E. (10)		4	2

Second Semester.

Calculus, Eng. Math. (5)	5		5
Analytic Mechanics, C. E. (8)	3		3
Physics, Physics (2)	3	4	5
Drawing, M. E. (4)	1	4	3
English, Eng. (4)	3		3
Shopwork, M. E. (11)		6	3

JUNIOR YEAR.

First Semester.

Mechanics of Materials, C. E. (9)	3		3
Machine Design, M. E. (5)		4	2
Boilers, M. E. (18)	2		2
Electrical Measurements, Physics (3)	2		2
Electric Machinery, E. E. (1)	3		3
E. E. Laboratory, E. E. (9)		4	2
Materials Testing Laboratory, C. E. (11)		4	2
Shopwork, M. E. (12)		4	2
Philosophy, Phil. (1)	4		4

Second Semester.

	Hours Attendance Rec.	Lab.	Credits.
Hydraulics, C. E. (21)	3	2	4
A. C. Machinery, E. E. (2)	3		3
Steam Machinery, M. E. (19)	3		3
Machine Design, M. E. (6)		4	2
E. E. Laboratory, E. E. (10)		6	3
Shopwork, M. E. (13)		4	2
Philosophy, Phil. (2)	4		4
Surveying, C. E. (32)		2	1

ELECTRICAL ENGINEERING.
SENIOR YEAR.

First Semester.

Thermodynamics, M. E. (20)	4		4
Internal Combustion Engines, M. E. (21)	3		3
Electrical Design, E. E. (6)		6	3
Alternating Currents, E. E. (3)	2	4	4
Telephony, E. E. (4)	2		2
E. E. Laboratory, E. E. (11)		6	3
Philosophy, Phil. (3)	3		3

Second Semester.

Power Plant Design, E. E. (7)	1	4	3
Electric Railways, E. E. (5)	2		2
Electrical Design, E. E. (8)		4	2
E. E. Laboratory, E. E. (12)		4	2
Contracts and Specifications, C. E. (31)	2		2
Political Economy, Pol. Econ. (1)	2		2
Business Law, Law (1)	1		1

	Hours Attendance Rec.	Lab.	Credits
Technical Literature, E. E. (13)	1		1
Thesis, E. E. Thesis			4
Philosophy, Phil. (4)	3		3

MECHANICAL ENGINEERING.
SENIOR YEAR.

First Semester.

Thermodynamics, M. E. (20)	4		4
Internal Combustion Engines, M. E. (21)	3		3
Industrial Engineering, M. E. (23)	3		3
Machine Design, M .E. (7)		4	2
Graphics, C. E. (18)	3		3
M. E. Laboratory, M. E. (16)		4	2
Shopwork, M. E. (14)		4	2
Philosophy, Phil. (3)	3		3

Second Semester.

Technical Literature, M. E. (27)	1		1
Power Plant Design, M. E. (8)	1	2	2
Industrial Engineering, M. E. (24)	3		3
Hydraulic Motors, M. E. (22)	2		2
M. E. Laboratory, M. E. (17)		4	2
Business Law, Law (1)	1		1
Contracts and Specifications, C. E. (31)	2		2
Political Economy, Poly. Econ. (1)	2		2
Thesis, M. E. Thesis			4
Philosophy, Phil. (4)	3		3

ARCHITECTURE.

(1) Descriptive Geometry.

Two Credits. **Four Hours, Drawing.**
First Semester.

Problems in point, line, plane, curved surfaces and double curved surfaces of revolution. Intersection of planes and solids. Development of solids. Plane surface solids. Intersection of solids. Perspective. Shades and shadows. Isometric projections. Applications, Prerequisite, M. E. (2).

(2) Descriptive Geometry.

Two Credits. **Four Hours, Drawing.**
Second Semester.

Continuation of (1). Prerequisite, Arch. (1)

(3) Design.

Two Credits. **Four Hours, Drawing.**
First Semester.

The student is taught to draw with neatness and precision the various Orders. Free scope is given him to bring into play his designing ability. This course is a preparation for general architectural composition and aims to bring out and direct along proper channels whatever ability in designing the student may have. At first simple problems are given but as the student's ability increases he is given more difficult problems.

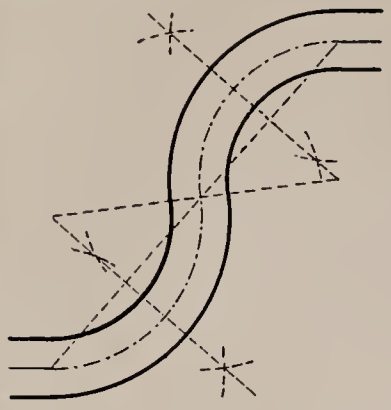
(4) Design.

Two Credits. **Four Hours, Drawing.**
Second Semester.

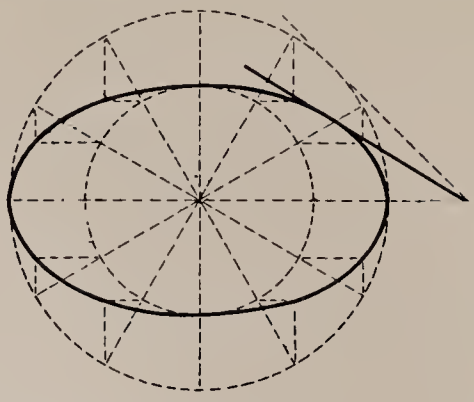
Continuation of (3). Prerequisite, Arch (3).

PLATE 5

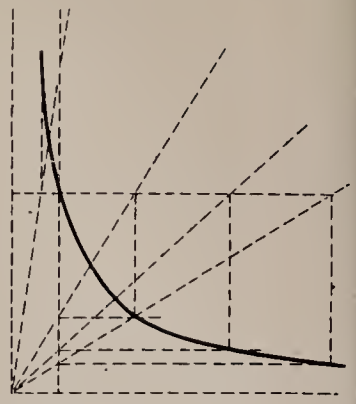
A reverse or "ogee" curve



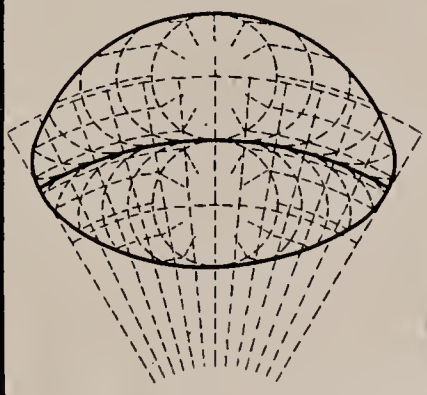
Ellipse – First Method



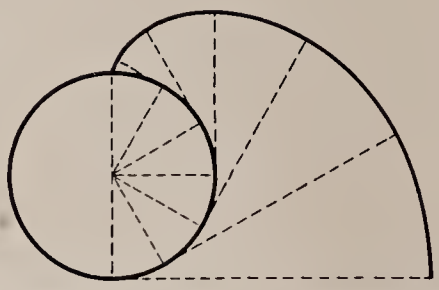
Hyperbola



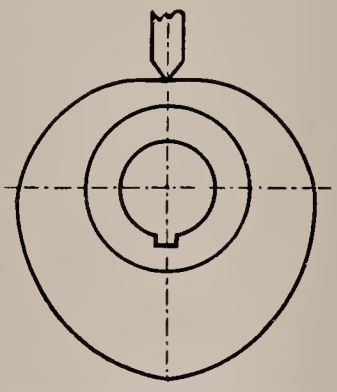
Epicycloid and hypocycloid



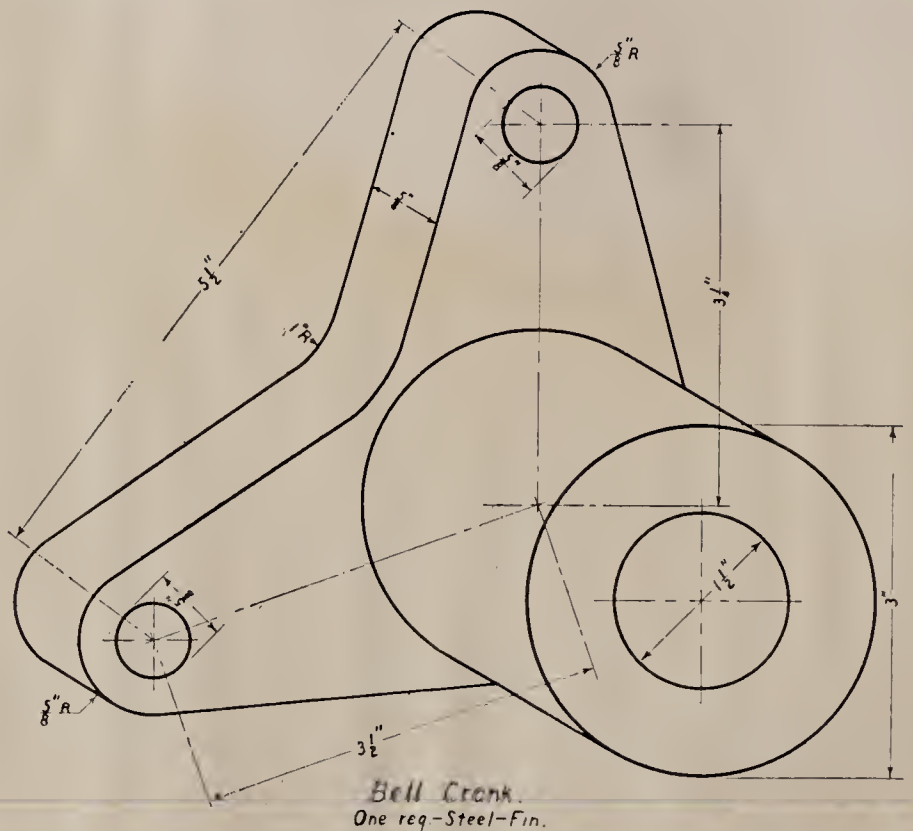
Involute of a circle.



Heart Cam



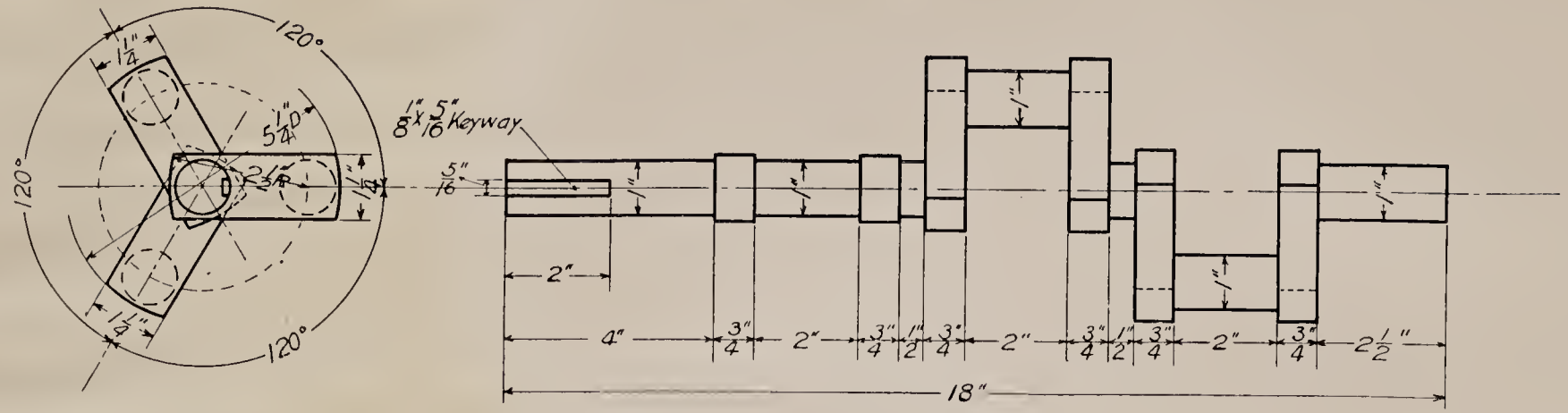
Wm. R. Holmes, Nov., 12, 1912



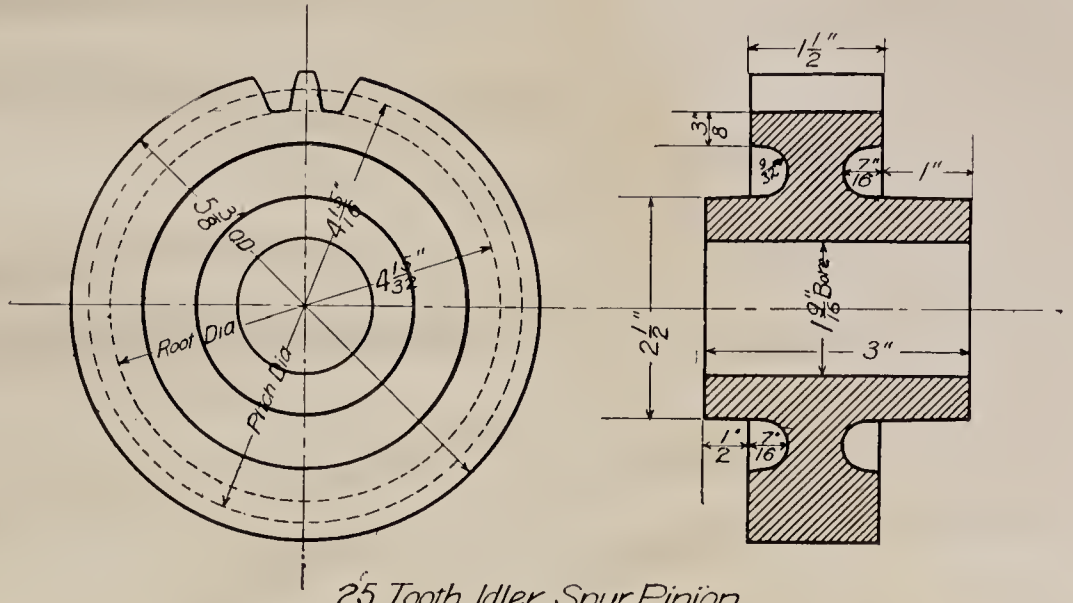
Feb. 20, '13. F. L aine.

SAMPLES OF WORK IN FRESHMAN MECHANICAL DRAWING

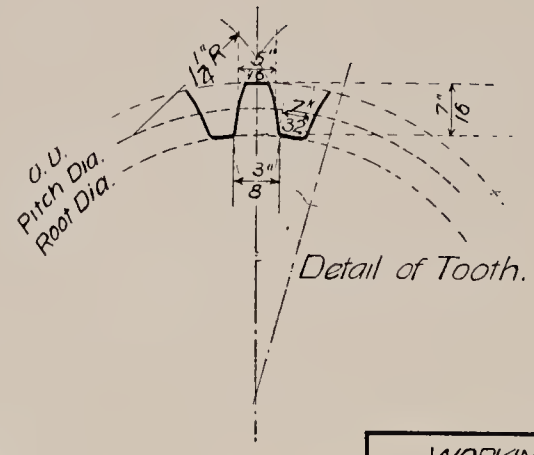
SAMPLES OF WORK IN FRESHMAN MECHANICAL DRAWING



Three Throw Crank Shaft.



25 Tooth Idler Spur Pinion.



Detail of Tooth.

WORKING DRAWING	
UNIVERSITY OF SANTA CLARA	
DEPARTMENT OF MECHANICAL ENGINEERING	
TIME 7 HRS.	APPROVED BY G. L. J
DATE, JAN 21,13	DR'N BY I. ALVIN OLIVER

(5) Design.

Six Credits. **Twelve Hours, Drawing.**
First Semester.

Continuation of (4). Prerequisite Arch. (4).

(6) Design.

Six Credits. **Twelve Hours, Drawing.**
Second Semester.

Continuation of (5). Prerequisite, Arch. (5).

(7) Design.

Four Credits. **Eight Hours, Drawing.**
First Semester.

Continuation of (6). Prerequisite Arch. (6).

(8) Freehand Drawing.

Two Credits. **Four Hours, Drawing.**
First Semester.

Drawings are made from casts and afterwards from life. In all drawings precision and neatness in free-hand work is demanded.

(9) Freehand Drawing.

Two Credits. **Four Hours, Drawing.**
Second Semester.

Continuation of (8). Prerequisite Arch. (8).

(10) Freehand Drawing.

Two Credits. **Four Hours, Drawing.**
First Semester.

Continuation of (9). Prerequisite Arch. (9).

(11) Freehand Drawing.

Two Credits. **Four Hours, Drawing.**
Second Semester.

Continuation of (10). Prerequisite Arch. (10).

(12) Freehand Drawing.

Two Credits. **Four Hours, Drawing.**
First Semester.

Continuation of (11). Prerequisite Arch. (11).

(13) Freehand Drawing.

Two Credits. **Four Hours, Drawing.**
Second Semester.

Continuation of (12). Perequisite Arch. (12).

(14) Strength of Materials.

Four Credits. **Four Hours.**
First Semester.

This course covers the derivation and use of formulae in dimensioning architectural structures. Numerous problems are assigned to give the students speed and accuracy in the manipulation of formulae. The laws of stresses and deformations of materials are discussed and methods of determining the shearing forces and bending moments in beams are explained. This course is intended for those who are taking Architecture and have not enough mathematics to take the courses in Applied Mechanics.

(15) Strength of Materials.

Four Credits. **Four Hours.**
Second Semester.

Continuation of (14). Prerequisite Arch. (14).

(16) History of Architecture.

Two Credits. **Two Hours.**
First Semester.

Fully illustrated lectures and recitations are given

on the Architectural history of different periods. The outlines of general history are studied in conjunction with the architecture of the times in order to enable the student to appreciate the relation of the people and their architecture. A careful study is made of the various examples of the great architectural styles of these times and also of painting and sculpture.

(17) History of Architecture.

Two Credits. **Two Hours.**
Second Semester.

Continuation of (16). Prerequisite Arch. (16).

(18) History of Architecture.

Two Credits. **Two Hours.**
First Semester.

Continuation of (17). Prerequisite Arch. (17).

(19) History of Architecture.

Two Credits. **Two Hours.**
Second Semester.

Continuation of (18). Prerequisite Arch (18).

(20) Construction.

Two Credits. **Four Hours.**
First Semester.

A course intended to give the student the fundamental notions. Foundations are studied and their adaptability to various soils. Manufacture of lime and cement; bricks and their manufacture; stone quarrying and dressing.

(21) Construction.

Two Credits. Two Hours.
Second Semester.

After the course in general construction, constructions in frame of wood, stone and brick are carefully studied.

(22) Construction.

Three Credits. Three Hours.
First Semester.

A course in steel and reinforced concrete construction.

(23) Construction.

Three Credits. Three Hours.
Second Semester.

Different varieties of stone and terra cotta, and their use in the various forms of architecture. General problems of construction with various stones.

(24) Pictorial Drawing.

Three Credits. One Hour Lecture, Four Hours, Drawing.
First Semester.

A study of isometric, oblique, axonometric, and perspective projection.

(25) Pictorial Drawing.

Three Credits. One Hour Lecture, Four Hours, Drawing.
Second Semester.

Continuation of (24). Prerequisite Arch. (24).

(26) Sanitation.

Two Credits. Two Hours.
First Semester.

The draining and sewage of buildings, traps and

systems of trapping, plumbing, fixtures, sewage removal and disposal, improved methods of house drainage and sanitary plumbing. Tests.

(27) Steel and Fireproof Details.

Two Credits. **Two Hours.**
First Semester.

A study of the different varieties of fire-proofing material and the methods of fire-proof building.

(28) Interior Decoration.

Two Credits. **Two Hours.**
First Semester.

Students are taught the designing of fire places, stairways, halls, ceilings, wainscoting and the like. Also such ornamental designs for interior or exterior work that will bring into practice what he has learned of the various styles of architecture and their combinations. Plans are made of these in various scales.

CHEMISTRY.

(1) General and Inorganic Chemistry.

Three Hours Lecture, Four Hours, Laboratory.
Five Credits. **First Semester.**

Discussion of Fundamental Laws, Mathematics of Chemistry. Ordinary elements studied from the standpoint of the Periodic Law. Practical demonstration of Laws and Theories.

(2) General and Inorganic Chemistry.

Three Hours Lecture, Four Hours, Laboratory.

Five Credits. **Second Semester.**

Ordinary and rarer elements from the standpoint of the Periodic Law. Metallurgy, with particular adaptation to the needs of Engineering students. Practical demonstration of principles discussed. Manufacture of Iron, Steel, Cement, Gas, Lubricants, Distillates, Pigments and Alloys. Prerequisite Chem. (1).

CIVIL ENGINEERING.

(1) Surveying.

One Hour Lecture, Two Hours, Laboratory.

Two Credits. **First Semester.**

Theory, construction, use and adjustments of tape, compass, levels and transit. Land and city surveying. Plotting, field work and computation of areas. Division of land. Simple leveling. Complete maps. Practical field work covering all matter taught in class work. The object is to thoroughly familiarize the student with the instruments and with field conditions. Field notes. Field maps. Topographical sketching without instruments. Prerequisite Eng.. Math. (2).

(2) Surveying.

One Hour Lecture, Four Hours, Laboratory.

Three Credits. **Second Semester.**

Continuation of (1). Prerequisite C. E. (1).

(3) Field Engineering.

One Hour Lecture, Four Hours, Laboratory.

Three Credits. **First Semester.**

Leveling, contour lines, hachures, cross-section

work. Use of plane table. Maps of work. Stadia. Transit stadia. City, mine, hydrographic and topographic surveying. Engineering office work. Plotting profiles and cross-sections. Calculation of areas. Computation of volumes of earth work and masonry. Draughting field notes. Excavation methods in different materials. Estimate of cost. Overhaul. Application to canals, trenches, embankments, dredging, etc. Practical surveying in the field under all the heads in the scope of the work in class. Notes. Calculations. Conditions made as nearly those of a corps in the field as possible, each student being required to fill every position in turn.

(4) Field Engineering.

Two Hours Lecture, Two Hours, Laboratory.

Four Credits. **Second Semester.**

Continuation of (3). Prerequisite C. E. (3).

(5) Engineering in Field.

Three Credits. **Six Hours, Laboratory.**

First Semester.

Reconnaissance. Location, preliminary survey and grade stakes for highways, canals and railways. Plots and calculations from notes. Theory of railway curves; simple, compound and taper curves. Locating sidetracks, switches, yards. Cross-sectioning. Triangulation. The work is made as nearly practical as possible and covers the theories and principles taught in class work. Prerequisite C. E. (4).

(6) Engineering in Field.

Two Credits. **Four Hours, Laboratory.**

Second Semester.

Continuation of (5). Prerequisite C. E. (5).

(7) Analytic Mechanics.

Three Credits. **Three Hours.**

First Semester.

General theories and principles concerning matter, inertia, space and time, motion, velocity and acceleration. Momentum. Force. Measures. Comparison and representation of force. Statics: Composition and resolution of concurring forces. Conditions of equilibrium. Composition and resolution of forces acting on a rigid body. Center of gravity. Friction. Virtual velocities. Machines. Funicular polygon. Attractions. Rectiliniar and curviliniar motion. Kinetics: laws of motion. Motion under the action of a variable force; and in a resisting medium. Central forces. Constrained motion. Impact. Work and energy. Moments of inertia. Rotary motion. Motion of a system of rigid bodies in space.

Effort is made throughout the course to direct the attention of the student to practical application of mathematical deductions. Prerequisites Eng. Math. (3) and taking Physics (1).

(8) Analytic Mechanics.

Three Credits. **Three Hours.**

Second Semester.

Continuation of (7). Prerequisite C. E. (7).

(9) Mechanics of Materials.

Three Credits. **Three Hours.**

First Semester

Resistance and elasticity of materials. Pipes, cylinders and riveted joints. Simple and cantilever beams. Restrained and continuous beams. Columns, shafts

and girders and designing same. Torsion in shafts. Combined stresses. Strength and resilience of materials. Tension and compression. Flexure of beams. Shear and torsion. Apparent and true stresses. Plates, spheres and columns. Analytical and graphical methods used in the solution of problems. Prerequisites Eng. Math. (5) and C. E. (8).

(10) Materials Testing Laboratory.

One Credit. **Two Hours, Laboratory.**
First Semester.

Tests of iron, steel, wood and concrete in tension, compression, shear, bending and torsion. Rattler tests on brick and standard tests on road materials.

Prerequisite—must be taking C. E. (9).

(11) Materials Testing Laboratory.

Two Credits. **Four Hours, Laboratory.**
First Semester.

Same as C. E. (10) only more complete. Especially for students in Architecture, Architectural Engineering, Electrical Engineering and Mechanical Engineering. Prerequisite—must be taking C. E. (9).

(12) Drawing.

Two Credits. **Four Hours, Drawing.**
First Semester.

Shading by lines and colors. Topographical drawing and lettering. Conventional signs, etc. Maps of work done in field. Completed maps in pencil, pen and colors. Blue prints. Prerequisite M. E. (1).

(13) Drawing.

Two Credits. **Four Hours, Drawing.**
Second Semester.

Continuation of (12). Prerequisite C. E. (12).

(14) Structural Design.

Two Credits. **Four Hours, Drawing.**
First Semester.

Mechanical drawing. Design and working drawing of machinery. Design and drawing of dams in earth, stone, wood, concrete and reinforced concrete. Piers, retaining walls and abutments in different materials. Design and drawings of concrete and reinforced concrete arches, culverts and bridges. Trestles and viaducts. Simple bridges. Problems under certain conditions are given students from which the design is to be evolved. Drawings giving in detail the structure of the design are required.

Prerequisite—must be taking C. E. (10).

(15) Structural Design.

Two Credits. **Four Hours, Drawing.**
Second Semester.

Continuation of (14). Prerequisite C. E. (14).

(16) Design.

Two Credits. **Fours Hours Drawing.**
First Semester.

Analysis, design, estimate and drawings for a concrete or reinforced concrete dam, retaining wall, culvert or abutment. Same for a reinforced concrete bridge, either of solid arch, rib arch, girder or slab construction. Analysis, design and drawings for a

trussed bent or tower in wood or steel. Analysis, design and drawings for a steel truss highway or railway bridge. In connection with this course, the student will be kept in touch with the latest methods and details of construction.

Prerequisite C. E. (15).

(17) Thesis.

Three Credits. **Six Hours.**
Second Semester.

Original investigation of some Engineering problem.

(18) Graphics.

Three Credits. **Three Hours.**
First Semester.

Principles and methods. Application to roof trusses under dead, snow and wind loads. Complete stresses for triangular and crescent trusses. Unsymmetrical loads and trusses. Bridge trusses. Stresses due to dead, snow, wind, initial tension and live loads. Bowstring trusses. Stress loads. Locomotive wheel loads. Plate girders. Shears. Moments. Trusses with broken chords. Miscellaneous trusses. Elastic deformation of trusses. Application to other engineering structures.

(19) Graphics.

Three Credits. **Three Hours.**
Second Semester.

Continuation of (18). Prerequisite C. E. (18).

(20) Masonry.

Four Credits. **Four Hours.**

First Semester.

Study of materials, stone, brick, terra-cotta, limes, cements, sand, gravel and broken stone. Tests for each, especial attention being paid to limes and cements. Proportions and use of lime and cement mortars. Plain concrete; materials, proportions, forms for, making and placing, waterproofing, strength, weight and cost. Reinforced: beams, columns and slabs; reinforcement of each. Details of construction, including forms, placing reinforcement and concrete, removal of forms, expansion and contraction. Separately moulded members. Concrete building blocks and artificial stone. Stone cutting. Stone Masonry. Classification of stone masonry. General rules for laying. Concrete rubble. Cyclopean concrete. Strength. Brick Masonry. Strength. Construction. Waterproofing. Ordinary foundations. Bed of foundation. Designing footings. Preparing bed under different conditions. Pile foundations. Wood, concrete, reinforced concrete and steel piles. Pile driving. Bearing power. Arrangement of foundation. Foundations under water. Coffer-dam, crib and open-caisson process. Dredging through wells. Pneumatic process as used in buildings, rivers and subways. Freezing process. Masonry dams. Stability of gravity dams. Outlines of the design. Concrete and reinforced concrete dams. Liquid pressures. Causes of failure. Construction details of retaining walls. Theory of stability. Bridge abutments and piers. Culverts. Voussoir Arch. Stability of arches. Theory of arches and methods of failure. Elastic

arch. Plain concrete fixed-end arches. Reinforced concrete hingeless arch. Hinged arch. Laboratory work in tests. Lectures giving further data, especially in reference to reinforced concrete and steel-concrete construction and reservoir dams.

(21) Hydraulics.

Three Hours Lecture, Two Hours, Laboratory.
Four Credits. **Second Semester.**

Fundamental data. Hydrostatics. Theoretical hydraulics. Instruments and observations, especially meters and pressure gauges. Flow through orifices. Flow over weirs. Flow through tubes and pipes. Flow in conduits. Flow of rivers. Water supply and water power. Dynamic pressure of water. Water wheels. Overshot, breast, undershot, vertical impulse, horizontal impulse and downward flow impulse wheels. Special forms of wheels. Turbines. Classification. Theory and design of turbines. Downward-flow and impulse turbines. Special devices. Naval hydro-mechanics. Pumps and pumping. Force and centrifugal pumps. Pumping engines. Other kinds of pumps. Pumping through pipes, and through hose. Hydraulic motors. Hydraulic-electric analogies. Stress is laid upon the effect of hydraulic laws upon engineering construction in or under water, especially in problems involving the impounding of water, or oil.

(22) Roof, Bridge and General Trusses.

Four Credits. **Four Hours.**
First Semester.

Analysis and deduction of stresses in members of roof trusses under different loads. Different types of

highway and railway bridges under dead loads. Live loads. Final stresses in bridge trusses. Types of American bridge trusses. Bridge bracing, members and floors. Deflection and least work. Cantilever trusses and cranes. Swing bridges. Hinged trusses. Viaducts. Principles of economic design. Details and design of pin truss bridge. Highway bridges. Railroad riveted bridges.

(23) Roof, Bridge and General Trusses.

Four Credits. **Four Hours.**
Second Semester.

Continuation of (22) Prerequisite C. E. (22).

(24) Roads and Pavements.

Two Credits. **Two Hours.**
First Semester.

Different types of highways. Economic location of highways. Traction resistances. Gradients. Foundations. Preparing foundations. Drainage. Standard cross-sections. Natural, broken stone and other artificial roads. Materials and their adaptability to classes of traffic. Road coverings. Asphalts. Asphaltines and patented road coverings. Oils. Oiled roads. Dust prevention. Maintenance and repairs. Pavements. Paving materials. City streets. Width and cross-section, crown, gutters, curbs, footwalks and crossings. Street intersection and grades. Standard city street and street railway construction. Repairs. Lectures on improvement and changes in highway construction.

(25) Sewers and Sanitation.

Two Credits. **Two Hours.**
First Semester.

Principles of design. Types. Systems and general use. Standard sewer construction in different forms and materials. Standard and power systems. Sanitary problems involved. Methods of disposition of sewage. Garbage removal and disposition. Cost estimates. Design. Lectures on problems involved.

(26) Geodesy and Astronomy.

One Credit. **Two Hours, Laboratory.**
First Semester.

Class, field and observatory work. Methods of field work to obtain accurate results. Construction, use and correction of errors in instruments. Observatory determination of latitude, longitude, azimuth and time. Field work in determining parallels and meridians. Latitude and azimuth. Transit, altazimuth and sextant and their uses. Solar transit. Triangulations and adjustments. Compass variations. Especial attention directed to use and correction of engineering instruments and their adaptability to astronomical uses.

(27) Concrete and Reinforced Concrete.

Two Hours Lecture, Two Hours, Laboratory.
Three Credits. **First Semester.**

Lecture course supplemented by practical problems. Economic use and properties of concrete, reinforced concrete and steel concrete. Beams and theories of flexure. Columns. Retaining walls, drains, tanks, conduits and chimneys. Tests and desgin of arches.

Materials and methods of construction in foundations, buildings, bridges and conduit work. Facing and finishing. Forms. Falsework. Reinforcement; apportioning in girders, beams, columns and slabs. Systems of reinforcement. Placing reinforcement. Waterproofing. The object is to make the student familiar with the details of this modern construction.

(28) Tunneling.

Two Credits. **Two Hours.**
First Semester.

Classification of tunnels. Locating tunnels. Economic location. Different methods employed in tunnels under various soil conditions. Excavating. Removal of excavations. Blasting. Powders. Drills and machinery used. Economic distribution of forces. Heading and bench. Linings in wood, brick, concrete and reinforced concrete. Drainage. Ventilation. Rapid transit system. City subway work and methods.

(29) Irrigation.

Two Credits. **Two Hours.**
Second Semester.

Irrigation in general. Value, cost and returns. Drainage areas. Estimation of rainfall and discharge from drainage areas. Water units and duty. Streams, flow and discharge. Measuring devices. Canals and ditches; construction, alignment, slope and cross-section. Distribution. Application of water in irrigation. Storage work. Water supply and losses. Geological conditions affecting reservoir sites. Earth and masonary dams. Details of headworks, diversion weirs, waste ways, sluices and regulators. Pumping ma-

chinery. Maintenance. Water rights. Irrigation laws.

(30) Railway Construction.

Two Credits. **Two Hours.**
Second Semester.

Much of the course is also adapted to the construction of canals, highways, levees, etc. Reconnaissance. Location. Alignment, grade and distances. Parties. Staking out work. Grading. Organization of grading parties. Methods of grading. Machines, etc. Output of men, animals and machines. Volumes. Cut and fill. Overhaul. Finishing. Revetments. Drainage areas and waterways. Culverts, size and character. Tracklaying. Tracklaying machines. Surfacing. Ballast. Single and double track roads. Side tracks, switches, crossings and yards. Round houses. Shortening lines. Operating expenses. Maintenance. General and extra gangs. Camp hygiene. Right of way. This course is largely lecture work, using standard text-books and writings for reference.

(31) Estimates and Specifications.

Two Credits. **Two Hours.**
Second Semester.

Principally a lecture course, but supplemented by practical problems for which estimates and specifications must be submitted. Position of engineer in construction. Duties. Estimates. Corrections. Latitude allowed. Contracts. General kinds. Special. Specifications. Definiteness. Lectures on law of contracts.

(32) Surveying.

One Credit. **Two Hours, Laboratory.**
Second Semester.

Use and adjustment of tape, level and transit. For Electrical and Mechanical Engineers.

Announcement.

Beginning with the summer of 1914 the University Summer School of Field Work in Civil Engineering will be established in camp at Loyola, in the foothills of the Santa Cruz Mountains. This camp is so situated as to offer the student exceptionally ideal areas for field work in plain, foothill and mountain. The field work will be conducted by experienced field engineers, who will, in addition to the full technical course, give thorough instruction in practical camping, camp methods and camp hygiene. The course will be four weeks in length and will be obligatory upon both Junior and Senior Classes in Civil Engineering; each class being under separate instructors and doing individual work.

The course will embrace complete topographical surveys with different instruments, leveling, contouring, railway reconnaissance, preliminary and location survey, cross-sectioning, railway curves, highway surveys and location, maps and profiles, earthwork computation, estimates, watershed computation, irrigation problems and canal surveys, survey and estimate for dams, determination of latitude and longitude,

triangulation, base line, geodetic survey of large extent of country, etc.

A full outline of each course and corresponding instructors, date of opening, expenses, etc., will appear in the Engineering Bulletin to be published in the spring of 1914.

ELECTRICAL ENGINEERING.

(1) Electrical Machinery.

Three Credits. **Three Hours.**

First Semester.

Magnetic field. Magneto-motive force. Hysteresis. Elementary dynamo. The magnetic circuit. Armature core. Commutator. Brush shifting. Sparking at brushes and remedies. Different types of generators. Methods of transmitting, distributing and controlling direct current. Direct current series and parallel systems. Feeders and mains. High tension D. C. systems.

(2) Alternating Current Machinery.

Three Credits. **Three Hours.**

Second Semester.

Self and mutual inductance. Capacity. Impedance. Phase angle and power factor. Series and repulsion types. Synchronous motors. Induction motors, single and polyphase. Methods of starting. Speed control. Electric drive for cranes, elevators, presses, pumps, fans, mill-work, etc. Prerequisites Physics (3) and E. E. (1).

(3) Alternating Currents.

Two Hours Lecture, Four Hours, Drawing.

Four Credits. **First Semester.**

Electric power systems. Translating, controlling and transmitting equipment. Constant potential and constant current transformers. Efficiency, regulation and protection. Polyphase systems of generation. Two phase and three phase and conversion from one system to another. Calculation of alternating current transmission lines. Regulation of voltage. Power factor of systems. Switch-boards. Apparatus used on switch-boards. Location. Types. Pole lines. Cable and conduit systems. Prerequisites E. E. (2).

(4) Telephony.

Two Credits. **Two Hours.**

First Semester.

The magneto-telephone. The microphone. Carbon transmitters. Induction coils. Call methods. Series and parallel circuits. Subscribers equipment. Line disturbances. Common battery systems. Exchange equipment. Party lines. Automatic systems. Combined telegraphy and telephony. Wireless telegraphy. Generation of electrical waves. Transmitting and receiving apparatus. Prerequisites Physics (2) and E. E. (1).

(5) Electric Railways.

Two Credits. **Two Hours.**

Second Semester.

Train resistance due to tracks and bearing surfaces, curves, grades and air. Acceleration and braking. Speed-time curves. Motors for railway work. Con-

trollers. Distribution systems. Track construction. Bonding and electrolysis. Trucks, wheels and car bodies. Conduit, storage battery and third rail systems. Electric locomotives. Multiple unit control. Testing railway equipment. Financial considerations.

(6) Design of Direct Current Machinery.

Three Credits. **Six Hours, Drawing.**
First Semester.

Electrical and mechanical theory applied to the design of D. C. machinery. Switches, heaters, controllers, etc. Complete calculations and working drawings for a dynamo or motor, to fulfill given specifications. Prerequisite E. E. (1).

(7) Power Plant Design.

One Hour Lecture, Four Hours, Drawing.
Three Credits. **Second Semester.**

Design of a complete plant to furnish light for a city of a given size. Consideration of the elements: illumination, charges, operating expenses, income, organization and administration, reports, specifications, contracts and statistics. Prerequisites E. E. (3) and (6).

(8) Electrical Design.

Two Credits. **Four Hours, Drawing.**
Second Semester.

Design of alternators, transformers, induction motors and other alternating current apparatus. Thorough investigation and complete design of some unit assigned.

(9) Electrical Engineering Laboratory.

Two Credits. **Four Hours, Laboratory.**
First Semester.

Determination of the resistance of electric circuits. Relation between speed, field strength and voltage. Operation of shunt series and compound wound generators. Distribution of potential around commutator. Heat runs to determine load capacity. Stray power. Starting boxes. Counter electric motive force. Shunt, series, compound and differentially wound motors. Operation of shunt and compound wound generators in parallel. Distribution of load. Constant potential and constant current generators. Control of series circuits. Regulation of arc lamps. Prerequisites—must be taking E. E. (1).

(10) Electric Engineering Laboratory.

Three Credits **Six Hours, Laboratory.**
Second Semester.

Calibration of ammeters and voltmeters. Calibration and adjustment of A. C. and D. C. watt-hour meters. Determination of resistances. Measurement of inductance and capacity. Permeability of samples of iron and steel. Determination of hysteresis. Storage batteries. Testing. Candle-power of lamps from standard candle. Cable testing. Insulation resistance. Practice in operation of A. C. motors, generators and other apparatus. Prerequisite E. E. (9.)

(11) Electrical Engineering Laboratory.

Three Credits. **Six Hours. Laboratory.**
First Semester.

Alternating current circuits. Inductance, capacity,

impedance, phase, relation, true and apparent watts and power factor. Alternators. Magnetization curves. Losses and synchronous impedance. Synchronous motors. Methods of Synchronizing. Methods of starting rotary converters. Compounding. Calculation of efficiency. Alternators in parallel. Transformers. Regulation. Heating and efficiency. Use as induction regulators and phase changers. Wave shapes by instantaneous contact and by the oscillograph. Resonance. Methods of starting induction motors. Efficiency by brake tests. Operation of induction generator. Reports of complete tests on plants.

(12) Electrical Engineering Laboratory.

Two Credits. **Four Hours, Laboratory.**
Second Semester.

Continuation of (11). Prerequisite E. E. (11).

(13) Technical Literature.

One Credit. **One Hour.**
Second Semester.

Assigned readings and reports from current technical literature.

(14) Electricity.

Two Hours Lecture, Two Hours, Laboratory.
Three Credits. **Second Semester.**

A short course similar to E. E. (1) and E. E. (9) for Civil Engineering Students.

ENGINEERING MATHEMATICS.

(1) Algebra.

Three Credits. **Three Hours.**
First Semester.

Complete Algebra to include quadratic equations, then more particularly: ratio and proportion, progressions, imaginary and complex numbers, indeterminate equations, binomial theorem, variables and limits, inequalities, interpretation of results, logarithms, permutations and combinations, indetermined coefficients, determinants and graphic algebra.

(2) Trigonometry.

Two Credits. **Two Hours.**
First Semester.

Development of general formulae. Functions and their relations. Logarithms and their uses. Properties of triangles. Application of principles to practical problems in right and oblique triangles. Navigation in plane trigonometrical problems. Spherical trigonometry. Application to problems in astronomy and spherical mensuration.

(3) Analytic Geometry.

Five Credits. **Five Hours.**
Second Semester.

Loci. Lines. Circle. Different systems of coordinates. Conic sections. Supplementary propositions. Loci of second order. Plane curves of higher order. Solid analytical geometry, especially of surfaces of revolution. General equations. Prerequisites Eng. Math. (1) and (2).

(4) Calculus.

Five Credits. **Five Hours.**
First Semester.

Fundamental formulae and principles for differential and integral calculus. Maxima and minima. Curvature. Surfaces. Volumes. Indeterminate forms. Envelopes. Series. Expansion. Forms of intergration. Practical application. Prerequisite Eng. Math. (3).

(5) Calculus.

Five Credits. **Five Hours.**
Second Semester.

Continuation of (4). Prerequisite Eng. Math. (4).

(6) Differential Equations.

Two Credits. **Five Hours.**
Second Semester.

Analysis and deductions of formulae and equations used in physics, mechanics and engineering problems. Applications of formulae and equations given in engineering handbooks to problems. Practical problems and lectures. Prerequisite Eng. Math. (5).

(7) Method of Least Squares.

Two Credits. **Five Hours.**
Second Semester.

Study of principles and methods. Applications to solution of physical, astronomical, engineering and other problems. The student will be made familiar with this higher and more accurate method of solution of problems in his profession, especially triangulations.

This course does not occupy the whole time allotted in this semester, but the additional time will be devoted to structural design.

ENGLISH.

(1) Composition and Rhetoric.

Three Credits. **Three Hours.**
First Semester.

Lectures and recitations. The invention, arrangement, and presentation of material. The different species, historical, philosophical, scientific, critical, etc. masterpieces.

(2) Composition and Rhetoric.

Three Credits. **Three Hours.**
Second Semester.

Continuation of (1). Prerequisite Eng. (1).

(3) Rhetoric and Literature.

Three Credits. **Three Hours.**
First Semester.

A course in English Rhetoric and Literature. Students who show any deficiency in English are required to take moreover the course in Special Composition. One hour a week is devoted to the study of Engineering Literature.

(4) Rhetoric and Literature.

Three Credits. **Three Hours.**
Second Semester.

Continuation of (3). Prerequisite Eng. (3).

GEOLOGY.

(1) Geology.

Two Credits. **Two Hours.**
First Semester.

Brief Course in Mineralogy with access to a large and historical Geology. Particular attention is paid to structural Geology and the influences of Instructive and Engineering conditions. The student is made familiar with different stones by illustrating each recitation with specimens of the particular rocks treated, as well as their adaptability in construction, method of occurrence, etc.

(2) Mineralogy.

Two Credits. **Two Hours.**
Second Semester.

Brief Credits in Mineralogy with access to a large collection of specimens. Determination of unlabeled specimens. Crystallography. Blowpipe analysis. Includes a short course in Metallurgy. Iron ores and production of iron and steel. Percentage and effects of sulphur, silicon, manganese and carbon in iron and steel. Coals, Coke, Carbons and ash. Prerequisite Geology (1).

LAW.

(1) Business Law.

One Credit. **One Hour.**
Second Semester.

A brief course in Contracts, Sales, Negotiable Instruments, Real Estate, Partnership, Corporations and such other subjects as the professor may deem necessary or advisable.

MECHANICAL ENGINEERING.

(1) Mechanical Drawing.

Three Credits. **Six Hours, Drawing.**
First Semester.

Freehand lettering. Use of instruments. Plane problems. Freehand sketching. Orthographic, isometric and cabinet projections. Tracing and blue printing.

(2) Descriptive Geometry.

Three Credits. **One Hour Lecture, Four Hours, Drawing.**
Second Semester.

Orthographic projection of points, lines, planes, warped surfaces, etc., in the four angles of projection. Intersections. Tangents to curves and surfaces. Developments. Practical problems in stereotomy, surveying, architecture, belting layouts, etc. Prerequisites M. E. (1).

(3) Kinematics.

Two Credits. **Two Hours.**
First Semester.

Motion, velocity and acceleration of machine parts. Rolling cylinders and cones. Lobed wheels. Belts. Levers, cams. Linkwork. Gearing. Parallel and straight line motion. Intermittant linkwork. Aggregate combinations. Prerequisite M. E. (1).

(4) Machine Drawing.

One Hour Lecture, Four Hours, Drawing.
Three Credits. **Second Semester.**

Language of Mechanical Drawing. Conventional method of representing bolts, screws and other stan-

dards. Piping. Design and detailing simple parts to take tension, compression and shear. Study of different methods of drawing and dimensioning found on commercial working drawings. Accuracy, completeness and speed are required. Prerequisite M. E. (3).

(5) Machine Design.

Two Credits. **Four Hours, Drawing.**
First Semester.

Selection of materials for machine parts. Proper working stresses for different materials under dead, repeated and reversed loads. Determination of nature and distribution of stresses in each element of a machine. Friction. Design of such elements as crank shafts, machine frames, connecting rods, etc., when subject to tension, compression, shear, torsion, bending or any combination of these. Figuring weight and cost of manufacture. The kinematic layout of a machine for functional operation. The evolution of a design from preliminary sketch to complete working and assembly drawings, involving a study of strength, adaptability, symmetry, ease of operation, depreciation and cost of manufacture. In all this work the note-book is as important as the drawings.

Prerequisite M. E. (4).

(6) Machine Design.

Three Credits. **Six Hours, Drawing.**
Second Semester.

Continuation of (5). Prerequisite M. E. (5).

(7) Machine Design.

Two Credits. **Four Hours, Drawing.**
First Semester.

Continuation of (6). Prerequisite M. E. (6).

(8) Power Plant Design.

Three Credits. **Two Hours.**
Second Semester.

Sites. Comparison of high-speed engines, Corliss engines, steam turbines and gas engines. Cost and adaptability of different types of steam boilers. Condensers. Economizers. Superheaters. Pumps. Stokers. Piping. Complete layout of a plant with specifications and advertisement for bids.

(9) Review of Engineering Industries.

Two Credits. **Two Hours.**
First Semester.

Lectures and assigned reading on Engineering studies and work. This course is designed to teach the student how to study and to enable him to make a rational choice of a course of study.

(9a.) Review of Engineering Industries.

Two Credits. **Two Hours.**
Second Semester.

Continuation of (9).

(10) Shopwork.

Two Credits. **Four Hours, Laboratory.**
First Semester.

Use and care of saws, planes, square, etc. Layout of simple work from blue prints. Lathe tools and exercises in turning.

(11) Shopwork.

Three Credits. **Six Hours, Laboratory.**
Second Semester.

Patternmaking and foundry work. Use of shrink rule. Construction of typical solid, split and piece patterns and core boxes. Layouts from working drawings. Bench moulding. Dry sand, green sand and loam moulds. Swept work. Core making. Shop visits. Prerequisite M. E. (10).

(12) Shopwork.

Two Credits. **Four Hours, Laboratory.**
First Semester.

Management of forge fire. Shaping. Drawing. Upsetting. Swaging. Welding. Tempering. Die forging. Working different grades of iron and steel.

(13) Shopwork.

Two Credits. **Four Hours, Laboratory.**
Second Semester.

Cold-chisel, file and scraper. Work on the lathe, planer, drill, shaper, milling machine and grinder. Assembling, erecting and rigging.

(14) Shopwork.

Two Credits. **Four Hours, Laboratory.**
First Semester.

Continuation of (13). Prerequisite M. E. (13).

(15) Mechanical Engineering Laboratory.

Two Credits. **Four Hours, Laboratory.**
First Semester.

Method of investigation. Classification of errors.

Accuracy of numerical calculations. Autographic diagrams. Callibration of pressure gauges, thermometers, pyrometers, indicator springs, tachometers, planimeters, weirs, nozzles, orifices, pitot tubes, Venturi meters and dynamometers. Testing of lubricants. Density, viscosity, gumming, fire-test and cold test. Measurement of power by the prony brake, Alden brake, traction dynamometers and transmission dynamometers. Belt testing. Measurement of flow of liquids and gases by means of meters, nozzles, pitot tubes, etc. Moisture in stream by barrel, Hoadley, Barrus, throttling, separating and chemical calorimeters. Heating value of coals determined by the bomb calorimeter. Heating value of gas by Junker's calorimeter. Flue gas analysis with Orsat's apparatus. Complete tests of steam engines, boilers, gas engines, injectors, pumps and entire plants. Standard reports,

(16) Mechanical Engineering Laboratory.

Two Credits. **Four Hours, Laboratory.**
First Semester.

Continuation of (15). Prerequisite (15).

(17) Mechanical Engineering Laboratory.

Two Credits. **Four Hours, Laboratory.**
Second Semester.

Continuation of (16). Prerequisite M. E. (16).

(18) Boilers.

Two Credits. **Two Hours.**
First Semester.

Heat; conduction, convection and radiation. Heat of evaporation. Combustion. Smoke Quantity of air required. Methods of firing. Classification of

coals. Efficiency of combustion. Boiler horsepower. Types of boilers. Furnaces. Stokers. Draft. Boiler Scale. Water purification. Explosions. Testing. Care of Boilers. Prerequisite Physics (1).

(19) Steam Machinery.

Three Credits. **Three Hours.**

Second Semester.

Properties of steam. Slide-valve. Indicator. Simple and compound engines. High speed, Corliss and marine engines. Turbines. Steam pumps. Locomotives. Valve gears. Governors. Flywheels. Balancing. Steam engine performance. Prerequisite M. E. (18).

(20) Thermodynamics.

Four Credits. **Four Hours.**

First Semester.

Mechanical theory of heat. First and second laws of thermo-dynamics. Perfect gases. Saturated vapors. Superheated vapors. Hot air engine. Internal combustion engine cycles. Influence of engine cylinder walls. Friction of engines. Refrigerating machines. Injectors. Steam turbines. Prerequisite M. E. (19).

(21) Internal Combustion Engines.

Three Credits. **Three Hours**

First Semester.

The theory and design of gas, gasoline and oil engines, gas producer practice; the combustion of gaseous fuels. Prerequisite M. E. (20.)

(22) Hydraulic Motors.

Two Credits. **Two Hours.**
Second Semester.

Action of water on curved vanes. Forces developed and effect of impact. Work done. Centrifugal action. Reaction turbines. Vane form and arrangement. Axial, radial and mixed flow wheels. Losses due to friction, shock, leakage and residual velocity. Impulse turbines. Experiments with turbines of various types. Governors. Centrifugal pumps. Theory. Radial and curved vanes. Velocity of flow. Volute. Diffuser. Guide vanes in diffuser. Impeller passages. Balancing. Losses. Efficiency. Selection and arrangement of water-wheels. Governors and auxiliary apparatus. Relation between available water supply, possible output and perfection of development work. Draft tubes. Stop valves. Gates. Vacuum and pressure relief stand pipes. Analysis of typical installations. Water power costs.

Prerequisite C. E. (21).

(23) Industrial Engineering.

Three Credits. **Three Hours**
First Semester.

The economic element in shop processes. Conditions for most economic production. Functional operation of machine tools. Limits of economic production. Machines for performing specific operations. Time study. Labor saving devices in the shops. Distribution of cost of machine production between different processes, power, labor and material. Fixed charges. Layout of shops for most direct production. Layout of system of management and cost determining system. Prerequisite M. E. (13).

(24) Industrial Engineering.

Three Credits. **Three Hours**
Second Semester.

Continuation of (23). Prerequisite M. E. (23).

(25) Heating and Ventilation.

Two Credits. **Two Hours.**
First Semester.

Theory and Design the various systems for heating and ventilating buildings, including Hot Air, Hot Water, Steam and the plenum and vacuum systems, and central station heating.

(26) Heating and Ventilation.

Two Credits. **Two Hours.**
Second Semester.

Continuation from (25). Prerequisite M. E. (25).

(27) Technical Literature.

One Credit. **One Hour.**
Second Semester.

Readings and reports from current Engineering literature.

MODERN LANGUAGES.

(1) French.

Four Credits. **Four Hours.**
First Semester.

In this course the student is carefully drilled in elementary grammar up to the irregular verbs, attention also being given to acquiring a vocabulary of the more common words.

(2) French.

Four Credits. **Four Hours.**
Second Semester.

A continuation of the preceding course. Special attention is given to the more important irregular verbs, the memorizing of words, and translation of French into English and vice versa.

(3) German.

Four Credits. **Four Hours.**
First Semester.

Elements of German grammar. Drill in pronunciation. Vocabulary.

(4) German.

Four Credits. **Four Hours.**
Second Semester.

A continuation of Course 3. Syntax. Oral and written exercises. Reading from the more simple German prose.

(5) Spanish.

Four Credits. **Four Hours.**
First Semester.

Elements of Spanish grammar. Drill in pronunciation. Vocabulary. Translations.

(6) Spanish.

Four Credits. **Four Hours.**
Second Semester.

Continuation of (5).

PHILOSOPHY.

(1) Philosophy.

Four Credits. Four Hours
First Semester.

Lectures are given every week during both semesters of the Junior and Senior years on the various subjects treated in the more lengthy courses of the College of Philosophy and Letters.

(2) Philosophy.

Three Credits. Three Hours
Second Semester.

Continuation of (1).

(3) Philosophy.

Three Credits. Three Hours
First Semester.

Continuation of (2).

(4) Philosophy.

Three Credits. Three Hours
Second Semester.

Continuation of (3).

PHYSICS.

(1) Mechanics, Molecular Physics, Sound.

Three Hours Lecture, Four Hours, Laboratory.

Five Credits. First Semester.

General principles of matter. General properties of Bodies. Equilibrium. Gravity. The balance. Laws of falling bodies. Pendulum. Properties peculiar to Solids. Hydrostatics. Capillarity, endos-

mose, diffusion, absorption. Hydro-dynamics. The properties of gases. Barometers. Measurement of the elastic force of gases. Aerodynamics. Production, propagation and reflection of sound. Measurement of the number of vibrations. The physical theory of music. Prerequisite—must be taking Eng. Math. (4).

(2) Light, Heat, Electricity.

Three Hours Lecture, Four Hours, Drawing.

Five Credits. **Second Semester.**

Transmission, velocity, intensity and reflection of light. Mirrors. Single refraction. Lenses. Dispersion and achromatism. Optical instruments. The eye. Sources of light. Phosphorescence. Double refraction. Interference and polarization. Properties of magnetism. Methods of magnetism. Laws of magnetic action. Terrestrial magnetism. Fundamental principles of frictional electricity. Quantitative laws of electric action. Distribution. Electrostatic induction of influence. Electric machines. Condensation of electricity. Voltaic cell. Its modifications. Magnetic field due to current. Galvanometers. Ohm's law. Conversion of electric energy into heat. Thermo-electricity. Electro-dynamics. Electro-magnets. Magnetization of iron. Telegraphy. Electro-magnetic induction. Passage of electricity through gases. Magneto and dynamo electric machines. Diamagnetism. Connection between electricity and light. Physiological action of the current. Animal electricity. Prerequisite Phy. (1).

(3) Electrical Measurements.

Two Credits. **Two Hours.**

First Semester.

Elementary electro-statics. Electrification by friction, conduction and induction. Magnetism. Determination of horizontal force and magnetic moment. Fundamental experiments in Volatic electricity. The galvanoscope and the galvanometer. Determination of E. M. F. Wheatstone's bridge. Callibration of galvanoscope. Measurements of resistance. The high resistance differential astatic galvanometer. Measurement of galvanometer resistance. Thomson's method. Differential method. Use of slide meter bridge. Carey Foster's method. Measurement of very low resistances. The method of comparison of potentials, projection of equal potentials and auxiliary conductors. Measurement of high resistances. The direct deflection method. Electrolyte resistance. Electrolytic resistance by alternating currents. The tangent galvanometer. Use of the standard galvonometer and the determination of E. M. F. Application of Joule's law. Use of potential galvenometer. Determination of the magnetic elements. Electro-magnetism and electro-magnetic induction. Action of linear current on magnet. Biot and Savart's law. Proof of electro-magnetic laws. Magnetic action of a solenoid. Laws of the electro-magnet. Induction experiments. Induction balance of Hughes. Damping. Comparison of resistance by magneto conductor. Use of earth inductor. Study of magnetic distribution. The condenser. Determination of the absolute capacity of a condenser. Electrometers. Prerequisite Phys. (2).

POLITICAL ECONOMY.

(1) Political Economy.

Two Credits. **Two Hours.**

Second Semester.

Object. Production, distribution, circulation and consumption of wealth. Production of wealth. Earth and natural agents. Labor and industry. Capital. Distribution of wealth. Individual property. Share of laborers. Circulation of wealth. Exchange. Taxes. Applications. This course is designed to give the student a broader view of his standing as a professional man in the community.